PATENT APPLICATION

of

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for

FIBROUS FACED CEILING PANEL

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FIBROUS FACED CEILING PANELS

Background

[0001] This disclosure relates to suspended ceiling systems and more particularly to a novel and improved system using perforated metal ceiling panels that include a non-woven fibrous facing material on the lower exposed surface of the panel creating an aesthetically pleasing and durable with fire safety qualities in a sound absorbing paneled ceiling system.

[0002] By way of background but not limitation, suspended-ceiling systems typically include grid members that provide for oppositely extending ceiling panel support flanges. In these systems, the edges of the ceiling panels are installed by laying them in the panel opening created by the grid members. There are also suspended-ceiling systems that have grid members, which include channels designed to grip the vertically extending edges of metal ceiling panels. These ceiling panels are typically installed by snapping the flanges up into the grid member channel, and are generally referred to as "snap-up ceiling panels." Typical lay-in grid panels are manufactured from slag wool fiber and/or recycled paper and expanded perlite or fiberglass to create light weight aesthetic ceiling panels. Some of these grid panels do not provide durability or sound absorption qualities that are desired for use in commercial, residential and industrial space.

[0003] In view of the above, it should be appreciated that there is a need for a ceiling panel that provides for increased durabilty and sound absorption. The present disclosure satisfies these and other needs and provides further related advantages.

Summary

[0004] The disclosure may be described as a novel and improved suspension ceiling panel that includes enhanced sound deadening qualities and increased durability. In the preferred embodiment the panel comprises a metallic panel substrate including a plurality of apertures of varying sizes. The body is further adapted to be connected to the ceiling grid members. The outer exposed surface of the metallic panel substrate is covered by a non-woven fibrous material that is adhered thereto. The multi-dimensioned apertures formed in the panel substrate in combination with the non-woven fibrous fabric on the lower exposed surface of the panel not only provides the appearance of a traditional

acoustical panel but provides desirable sound absorption and resistance to flame spread and smoke generation.

[0005] Other features and advantages of the disclosure will be set forth in part in the description which follows and the accompanying drawings, wherein the embodiments of the disclosure are described and shown, and in part will become apparent upon examination of the following detailed description taken in conjunction with the accompanying drawings.

Brief Description of the Drawings

[0006] The above mentioned and other features of this disclosure and the manner of obtaining them will become more apparent and the disclosure will be best understood by reference to the following description of embodiments of the disclosure taken in conjunction with the accompanying drawings in which:

[0007] FIG. 1 is a perspective view of one type of ceiling system illustrating fibrous faced ceiling panels;

[0008] FIG. 2 is a sectional view of the ceiling system, taken along lines 2-2, illustrating the fibrous faced ceiling panels connected to a grid system;

[0009] FIG. 3 is a top view of the ceiling panel illustrating the spacing and sizes of the perforations;

[00010] FIG. 4 is a top view of the ceiling panel illustrating an alternate perforation pattern;

[00011] FIG. 5 is a perspective view of a ceiling system illustrating the fibrous faced ceiling panels transitioning from a first elevation to a second elevation;

[00012] FIG. 6 is another perspective view of a ceiling system illustrating the fibrous faced ceiling panels transitioning from a first elevation to a second elevation;

[00013] FIG. 7 is a perspective view of a ceiling system illustrating the transition from the fibrous faced ceiling panels to other types of ceiling panels; and

[00014] FIG. 8 is a perspective view of a ceiling system illustrating curved fibrous faced ceiling panels.

Detailed Description

[00015] While the present disclosure will be described fully hereinafter with reference to the accompanying drawings, in which a particular embodiment is shown, it is to be

understood at the outset that persons skilled in the art may modify the disclosure herein described while still achieving the desired result. Accordingly, the description that follows is to be understood as a broad informative disclosure directed to persons skilled in the appropriate art and not as limitations on the present disclosure.

[00016] As illustrated in the drawings, Fig. 1 illustrates a portion of an assembled suspension ceiling incorporating snap-up fibrous faced ceiling panels 10 in accordance with the present disclosure. In such a ceiling panel system, grid members 12 are interconnected to form a grid structure 13. The grid members 12 are arranged to form openings 14 sized to receive the ceiling panels 10. The grid members 12 are suspended from the building structure by wire hangers 16 or other supporting structures.

[00017] To create the grid structure 13, a row of parallel evenly spaced grid members 12 are suspended by wire hangers 16. Each row of the grid members 12 are spaced apart to accommodate the size of the fibrous faced ceiling panels 10. To accommodate a 2 foot by 2 foot ceiling panel, the grid members 12 would be spaced apart 2 feet on-center. The grid structure 13 also includes a second set of grid members 18 that are perpendicularly oriented in relation to the first set of grid members 12 to create the opening required for hanging the panels 10.

[00018] The fibrous faced ceiling panels 10 are normally rectangular, usually square in shape, and are preferably made out of metal. The panels 10 are durable in that they are impact resistant, self-supporting do not sag or fracture when perforated. Depending upon the ceiling design used, it may be desirable to shape the panels 10 into a square or curved shape, as shown in Fig. 8, but other shapes may be utilized. Other shapes would include transition panels, as shown in Figs. 5 and 6, which allow the transition from a first elevation to a second elevation. Figure 7 illustrates a decorative transition panel 55 without the facer material, which can be a low gloss or high gloss, reflective panel. While the preferred material used in fabricating the fibrous faced ceiling panels 10 is metal, other materials may be used including gypsum, wood, wood fiber, plastic and other substrate materials that allows perforation while retaining the basic shape and stiffness of the fibrous faced ceiling panels 10. Metal and plastic material, such as polycarbonate, are preferred since panels can be molded or stamped to include a desired shape or to form various edge configurations for connection to the grid structure 13. The

fibrous faced ceiling panels 10 include an interior face 20 and an exterior face 22. The panels 10 may also include a hinge 24 along a first corner 25 of the panel 10 to permit the panel to be pivoted to an open position with respect to the grid system 13. The panel 10 preferably includes flanges 26 along the edges 58 of the panel 10. While a flanged edge and a hinged edge are disclosed, other edge configurations may be used to secure the panels 10 to the grid system.

[00019] The fibrous faced ceiling panels 10, as shown in FIG. 1, illustrates the panels 10 connected to the grid structure 13 by use of flanges 26. It is beneficial to use the hinge 24 to support the ceiling panel 10 when all metal ceiling panels become as large as 4 feet by 4 feet, because the panels become awkward to install and remove due to their relatively large size and weight. Further illustrations of the use of a hinge can be found in U.S. Patent number 6,467,228, incorporated herein by reference. When working with a piece of sheet metal with such a large surface, any improper handling may result in damage to the overall finish of the ceiling panel 10. Also, by using the hinge 24 that spans the length of the ceiling panel 10, the weight of the panel is evenly distributed across the entire corner 25 of the panel 10, preventing rippling that would be apparent in the bottom surface 20 of the panel 10. Furthermore, once the ceiling panel 10 is connected to the grid members 12, the ceiling panel 10 will automatically be in alignment to allow for easy closure by pivoting the ceiling panel 10 upward and snapping in the flanges 26 into the grid.

[00020] FIG. 2 is a cross section of FIG. 1 taken along line 2-2 looking in the direction of the arrows and shows the grid member 12 and the hinge 24 along an corner 25 of a first ceiling panel 10 and the flanged edge 26 of a second ceiling panel 10. The grid member in this example 12 is fabricated out of a single piece of die-formed sheet metal. The grid member 12 after fabrication includes a bulb portion 34, a channel 36 and a double layer bridge portion 38 that connects the bulb portion 34 and the channel 36. The overall shape of the grid member 12 is to give the member 12 strength to prevent flexing. Typically, apertures (not shown) are placed along the length of the bridge portion 38 so that wire hangers 16 can be threaded through and wrapped around the bulb portion 34. Once the wire hanger 16, as shown in Fig. 1, which can be in the form of a wire, is threaded

through an aperture (not shown) and around the bulb portion 34, the wire hanger 16 is wrapped around itself several times to prevent it from unraveling.

[00021] The bridge portion 38 typically includes slots (not shown) that allow one grid member 12 to be connected to the second grid member 18 to form the grid structure 13. The channel 36, as shown in FIG. 2 is formed by bending the double layers of the bridge portion 38, 90 degrees outward, 90 degrees downward and 90 degrees inward to form a boxed channel 36. Bottom edges 42 are folded over to act as an engagement edge for the flange 26 and a retaining surface for the hinge 24. The hinge 24 is formed in the ceiling panel 10 by die-forming the hinge 24 90 degrees upward to create an upwardly extending leg 43 and then die-forming the edge 90 degrees inward to create an inward lip 44. The inward lip 44 of the hinge 24 rests upon the bottom edge 42 in the channel 36 of the grid member 12. The flange 26, shown in FIG. 2, is formed by die-forming or molding the edge 26 of the ceiling panel 10 upward 90 degrees to form a vertical member 45 and by forming a rib 48. The ceiling panel 10 is retained to the grid structure 13 by forcing rib 48 past the bottom edge 42. The rib 48 is properly positioned within the channel 36 when the rib 48 is resting upon the bottom edge 42. The vertical member 45 biases the rib 48 to prevent the ceiling panel 10 from moving out of position. While use of an edge with a rib 48 is preferred, other grid engagement mechanisms may be used including a lay-in arrangement wherein the edges 26 do not include a flange.

[00022] Figure 2 also illustrates a fibrous facer material 54 adhered to the exterior face 22 of the panel substrate 11 viewable from the environmental area of a building structure. The environmental area of the building structure is defined as the space within a building used by occupants to work or conduct other activities. It is the inhabitable space within a structure. From the environmental area, the fibrous facer material 54 is substantially exposed and viewable by the occupants below. The interior face 20 of the panel 10 is substantially concealed from the environmental area and is not viewable by the occupants below. The fibrous facer material 54 creates an aesthetically pleasing surface that gives the ceiling a soft appearance as opposed to a painted metallic ceiling panel, which has an undesirable shiny appearance.

[00023] Figure 3 is a top view of the fibrous faced ceiling panel 10 that illustrates the positioning of apertures 52 of a first diameter and apertures 53 of a second diameter

across the panel 10. The non-woven fibrous facer material 54 on the exterior face 22 of the panel 10 is adapted to cover the entire face 22 of the panel 10 including the apertures 52, 53. When the fibrous facer material 54 is applied to the panel 10, only the fibrous facer material 54 is visible from below. The panel substrate 11 or the apertures 52, 53 are not viewable from below. The sound absorption mechanism of the fibrous faced ceiling panels 10 is a combination of resonant absorber sound attenuation due to the resistance in air flow through the pores of the non-woven fibrous facer material 54 and the perforation of the panel 10. In order to maximize sound absorption at varying frequencies, three main parameters need to be optimized. This includes the extent of perforation of the panel 10 with apertures 52, the airflow resistance of the fibrous facer material 54 and the plenum height, i.e. the distance between the structure and the ceiling.

[00024] Figure 4 illustrates a top view of an alternate aperture arrangement wherein the panel 10 includes apertures 52 of a first diameter apertures 53 of a second diameter and apertures 55 of a third diameter. The combination of the three aperture sizes enhances the resistance of sound waves of varying frequency. The apertures 52 shown in figure 1 are all of a uniform size.

[00025] The extent of the perforation of the panel 10 is partially dependent upon the strength of the selected substrate material and its resistance to mechanical impact and to excessive panel flex. Substrates such as metal and plastic can be extensively perforated, while gypsum board is limited to no more than about 20% of its surface area in order to maintain strength. In order to achieve the proper sound deadening qualities, the substrate is perforated from about 10% to about 35% open area. Optimally, the percentage of the open area of the face 50 of the panel 10 should be about 30% to about 33%

[00026] Sound is made up of various frequencies. A cymbal for instance would emit a high frequency whereas a base drum would emit a low frequency. The varying amplitude of the frequencies renders it difficult to provide a medium that is sufficient at deadening sound. A particular media may be efficient at capturing low frequency noise but is incapable of capturing high frequency noise. In order to enhance sound absorption at different frequencies the substrate panel 11 is perforated with apertures of different diameters. More specifically, two or three different aperture sizes are preferred. For the panel 10 to achieve the desired sound deadening qualities, the diameter of the apertures in

the panel are from about .039 inches to about 0.117 inches to achieve the desired sound deadening qualities. Preferably, the perforated pattern is a combination of 15/128 of an inch apertures and 3/32 of an inch apertures. While circular apertures are preferred, oval triangular, polygonal, square or elliptical shaped apertures can also be used. Apertures with large diameters permit the passage of low frequency sounds with large amplitudes whereas apertures with smaller diameters permit the passage of high frequency sounds with smaller amplitudes.

[00027] Spacing between the panels 10 is important in order to gain the maximum benefits from the panels. In order to maximize the sound absorption qualities of the panels, it is sufficient that the gap tolerance between panels is in the range from about zero gap to about 3/8 of an inch and preferably from about a zero gap to a gap of about 1/4 of an inch. Spacing between the panels larger than 3/8 of an inch permits excessive sound to be deflected off of the grids 12 and back into the room, reducing the effectiveness of the ceiling system.

[00028] In testing of the panel 10 of the present disclosure smoke development and flame spread by the panel resulted in values substantially lower than industry standards. Limiting smoke development in a building fire is essential in order to increase the ability for occupants in the build to escape without being subjected to smoke inhalation. Typically in a fire, smoke inhalation, and not the fire itself cause death to the occupants.

[00029] The non-woven fibrous facer material 54 is applied to the panel substrate with use of an adhesive. The adhesive utilized to adhere the non-woven fibrous facer material 54 to the ceiling panel 10 is preferably a hot melt adhesive that is substrate compatible. The adhesive must also be compatible with the type of facer material 54 applied to the panel 10. While hot melt adhesive is preferred, it is foreseeable that other types of adhesives, such as spray, brush or roll-on adhesives may be used. The sound absorption qualities of the panel are also varied by the type and amount of the glue used on the fibrous facer material 54.

[00030] The panel substrate 11 and fibrous facer material 54 are designed to permit molding or stamping of the panel 10 into desired configurations to create flanges 26. Transition panels 57, as shown in Figs. 5 and 6 or curved ceiling panels, as shown in Fig. 8 may also be created by molding or stamping the panel. Transition panels 57 are used to

transition from a first ceiling elevation to a second ceiling elevation and can be formed by bending or curving the panels 10. In order to permit the panel 10 to be formed into the desired configuration, the panel substrate 11 is preferably made from steel, aluminum or polymer. The fibrous facer material 54 used to cover the exterior face 51 of the panel substrate 11 can be of various materials so long as the material does not rip or tear when formed with the panel. Certain materials when tested such as fiberglass tear or crack when the panel 10 is molded to create flanges 26 or other desired shapes. Preferred materials for use as a fibrous face material 54 include polymer mixtures having polyster fibers. Another such usable material is a combination of NYLON6 and Polyethylene. Polymer mixtures of fibrous materials, permit the passage of airflow through the material 54 and allow the panel 10 to be shaped after the fibrous material 54 has been adhered to the panel 10 without tearing the fibrous face material 54.

[00031] To achieve the desired sound deadening qualities, the panel substrate 11, in combination with the fibrous facer material 54 should have an airflow resistance from about 900 mks rayls to about 1050 mks rayls. Specific airflow resistance is the product of the airflow resistance of a specimen and its area. This is equivalent to the air pressure difference across the panel 10 divided by the linear velocity of airflow measured outside the panel 10. The airflow resistance of the fibrous facer material 54 in combination with the perforated panel substrate is critical to the efficiency of the acoustic attenuation process. If the airflow resistance is too high, the material reflects the sound wave as if it were a solid wall. If it is too low, the sound wave freely travels through the material. In either case the sound attenuation is less than optimum. The preferred airflow resistance of the facer material 54 should be about 100 mks rayls to about 600 mks rayls.

[00032] Airflow resistance of a panel 10 is defined as the ratio of the pressure drop across the material to the velocity of the gas passing through it and can be expressed in cgs rayls (dyne/cm^2 per cm/sec). Determination of flow resistivity is the main property in describing the acoustical performance of any porous material. Every fibrous material has specific flow resistance characteristics based on its manufacturing process or inherent nature. In the case of composite materials, such as the present panel 10, which is a combination of the fibrous facer material 54 and the perforated panel 10, it is important to understand the individual flow resistance of each component. However, for optimum

performance of the resultant panel 10, it is vital to tune the flow resistance of the entire system fibrous facer material 54 and panel substrate 11 to maximize sound absorption. As previously stated, this optimum airflow resistance is about 900 mgs rayls to about 950 mks rayls.

[00033] In most cases, plenum height 64 behind the panel 10 is limited and therefore the sound absorption performance of the panel 10 is restricted by the short plenum gap, as shown in Fig. 2. In order to further enhance the sound absorption of the panel 10 with a short plenum height a second layer of porous insulation material 56 such as glass fiber, mineral fiber, thermoplastic polymeric fiber, thermosetting polymeric fiber, carbonaceous fiber, milkweed fiber, or foam insulation, (with preference to polyolefin microfiber melt blow products) can be applied to the interior face 20 of the panel 10.

[00034] The panels 10 are designed with four edges 58 that are adapted to be connected to the grid structure 13. The panels 10 can be connected to the grid structure 13 using various edge configurations. The edges 58 of the panel 10 can include the vertical member 45 and a rib member 48. This allows the panel to be snapped into the bottom edges 42 of the grid members 12 and 18. In yet another alternative, the panel 10 does not include edges 25 and simply lays into the openings 14 created by the grid structure 13.

[00035] While the concepts of the present disclosure have been illustrated and described in detail in the drawings and foregoing description, such an illustration and description is to be considered as exemplary and not restrictive in character, it being understood that only the illustrative embodiments have been shown and described and that all changes and modifications that come within the spirit of the disclosure are desired and protected.

[00036] There are a plurality of advantages that may be inferred from the present disclosure arising from the various features of the apparatus, systems and methods described herein. It will be noted that alternative embodiments of each of the apparatus, systems, and methods of the present disclosure may not include all of the features described yet still benefit from at least some of the inferred advantages of such features. Those of ordinary skill in the art may readily devise their own implementations of an apparatus, system, and method that incorporate one or more of the features of the present disclosure and fall within the spirit and scope of the invention as defined by the appended claims.